




Project no. **GOCE-CT-2003-505540**

Project acronym: **Euro-limpacs**

Project full name: **Integrated Project to evaluate the Impacts of Global Change on European Freshwater Ecosystems**

Instrument type: **Integrated Project**

Priority name: **Sustainable Development**

Deliverable No. 318
Presentation of climate change related long-term data series to the US EPA at a climate change workshop (Task 2.5)

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Actual submission date: **Month 59**

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Organisation name of lead contractor for this deliverable: **Alterra**

Revision **FINAL**

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level (tick appropriate box)		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	



**Integrated Project to evaluate the Impacts of Global Change
on
European Freshwater Ecosystems**

WP2: Climate-hydromorphology interactions

Task 2: Hydromorphological changes and aquatic and riparian
biota

Subtask 2.5: Examination of existing time-series data

Deliverable No. 318

**Presentation of climate change related long-term data
series will be presented to the US EPA at a climate
change workshop (Task 2.5)**

Compiled by

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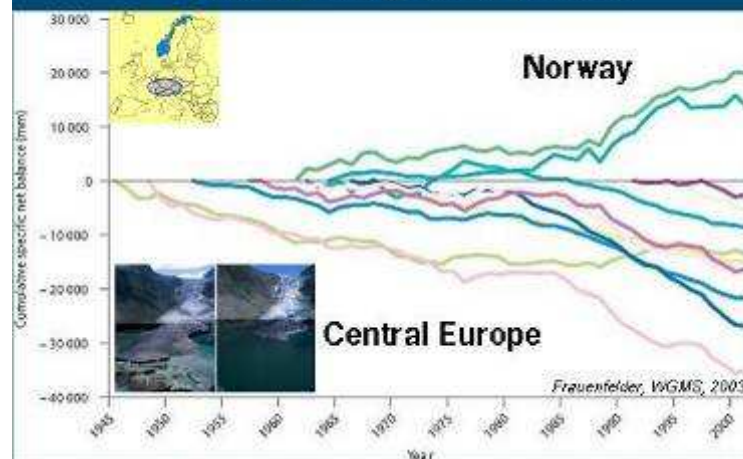
Part 2: Long-term data series

examples of indicators climate change

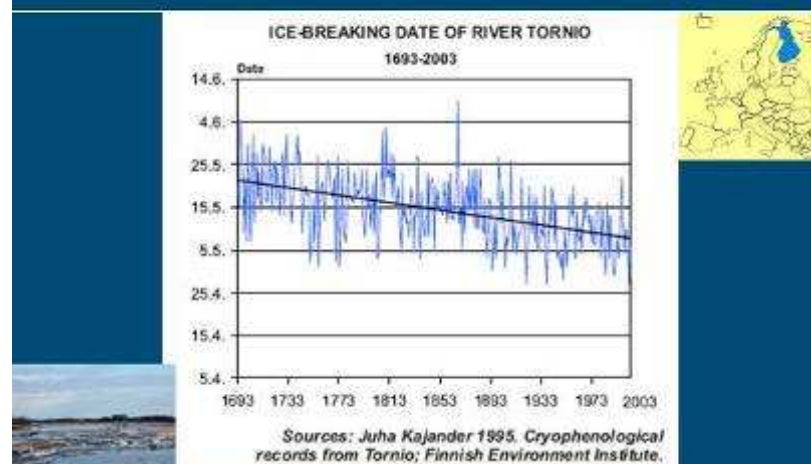
- signals of climate change in Europe
- historical data-series (Netherlands)
- decoupling of processes (Switzerland)
- timing/phenology in lakes (UK)
- lake ecosystem interactions (Europe)
- precipitation and stream discharge patterns (Sweden, Netherlands)



CC signal: glacier retreat



CC signal: ice-breaking



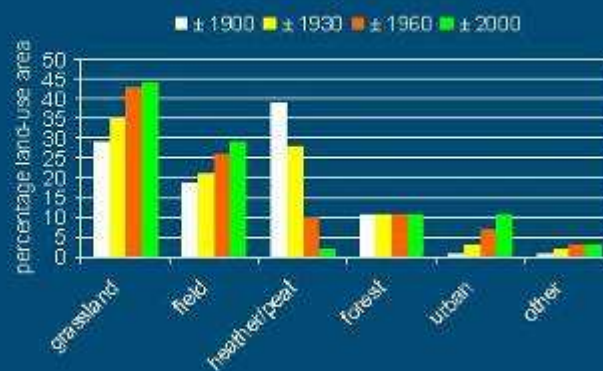
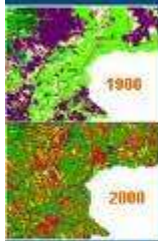
past changes at catchment scale



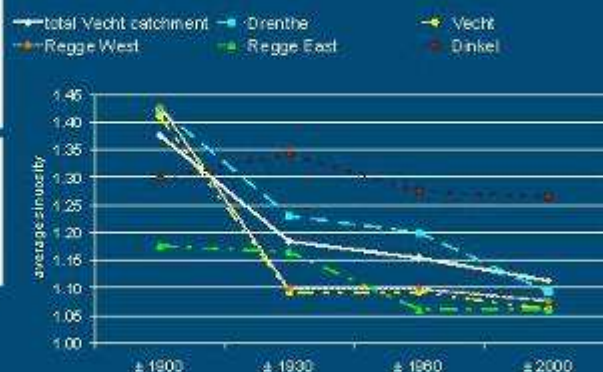
Analysis of historical data (existing knowledge 100 yrs)
from the Vecht catchment (The Netherlands)

- ✓ developments and interactions in land-use, hydrology and morphology
- ✓ impact of climate (change)
- ✓ ecosystem responses

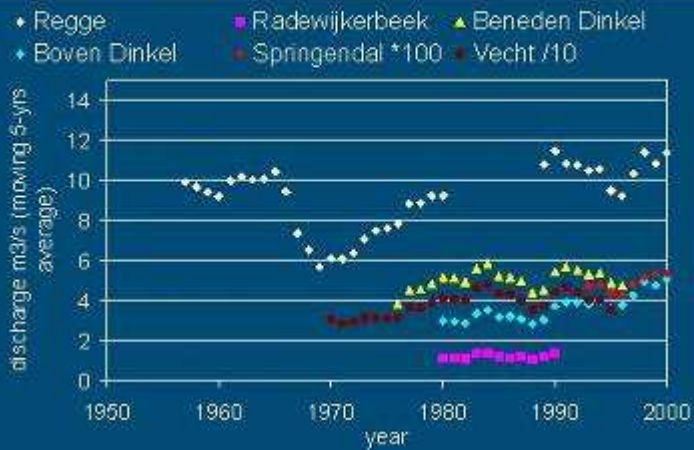
past changes in land-use



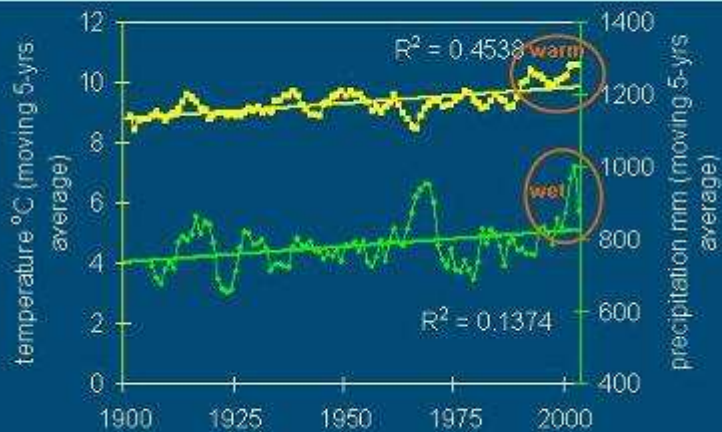
morphology: past changes in sinuosity



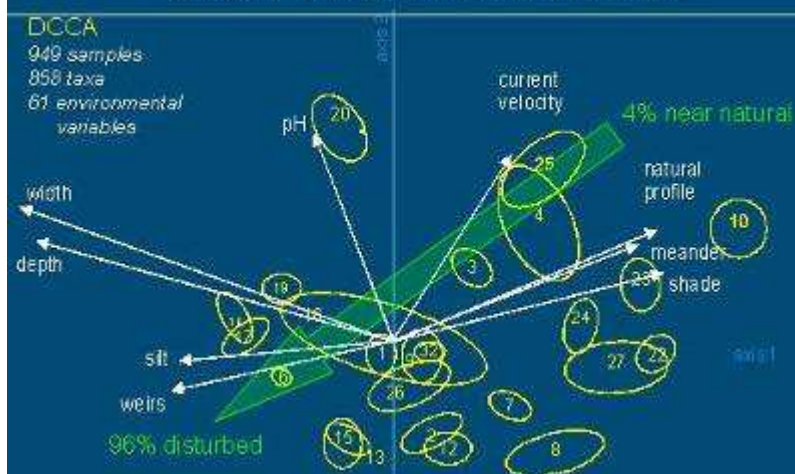
hydrology: past changes in discharge



changes in climate



>30 yrs of macroinvertebrates



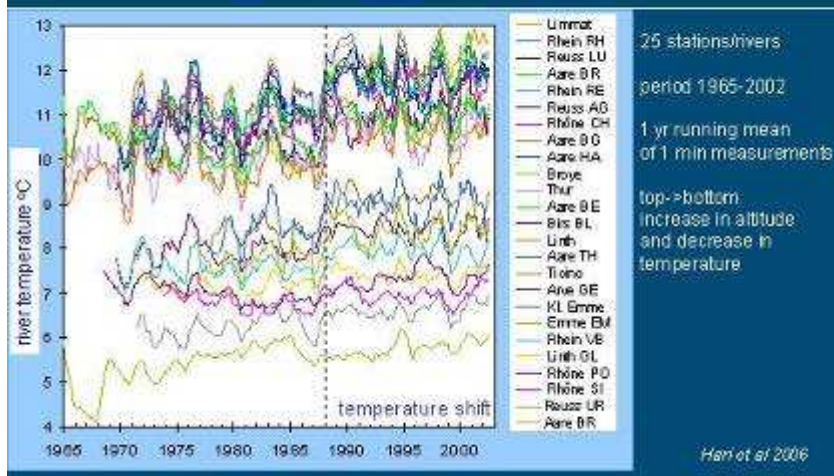
past changes: conclusions

- hydrological processes were poorly documented and showed little change after the 1970's, increase in the 90's
- morphology changed strongly (3 periods) due to changes in land-use not climate (mostly 1900-1930)
- changes in climate increased especially over the last 20-30 years
- anthropogenic change >>> climate change (until now)

decoupling: warming Swiss rivers



warming Swiss rivers



warming of Swiss rivers

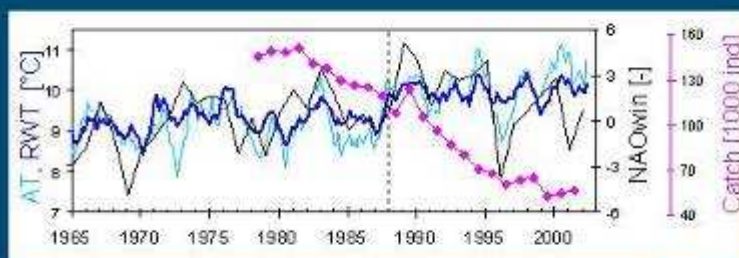


- warming: about 1°C increase
- synchronised temperature shift: 1987/88
- related to air temperature (not to discharge, precipitation, cloud cover, air pressure) and winter NAO (+)

Harl et al 2006

warming and brown trout

in rivers brown trout decreased by >50% over the last 50 years



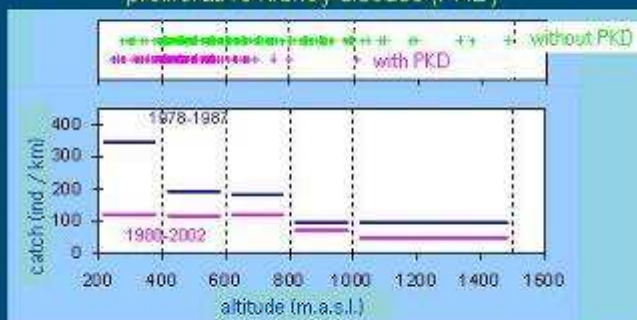
AT = air temperature
RWT = river water temperature (mean of all rivers)

Harl et al 2006



warming and brown trout

proliferative kidney disease (PKD)

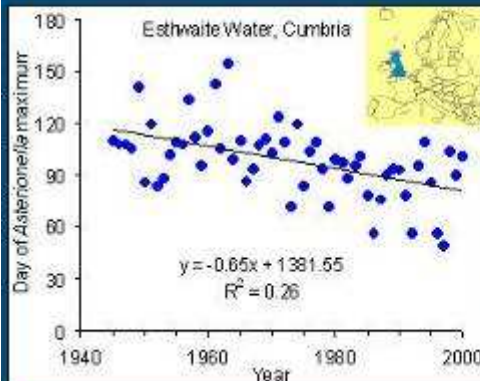


- thermal habitat shift: no upstream movement due to barriers
- effect PKD (increase by thermal shift)
- angler activity (decrease 20%)

Harl et al 2006

timing of algal spring bloom

- advancement of spring events (seasonal timing or phenology)
- example: timing of the peak spring phytoplankton (primarily diatoms) bloom



Asterionella formosa

data
R. C. Maberly
(CEH, UK)

timing of algal spring bloom

Is an earlier bloom due to a direct impact of climate change alone or are there other non-climate drivers?

climate processes:

- thermal stratification
- timing of ice-break up
- NAO (+, winter)

biological processes:

- replication vs sedimentation rate
- high overwintering population
- earlier grazing by zooplankton

climate drivers:

- temperature
- light

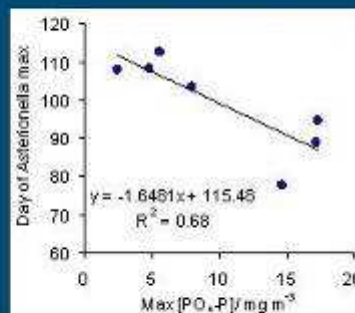
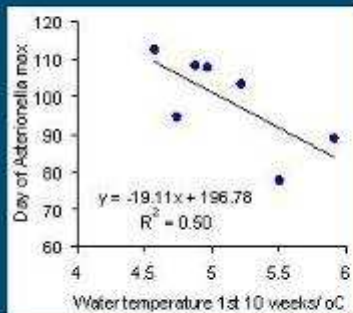
non-climate drivers:

- nutrient availability
- silica availability

Thackeray et al
(in prep.)

timing of algal spring bloom

relating change to possible environmental drivers



mean values in 10-year blocks

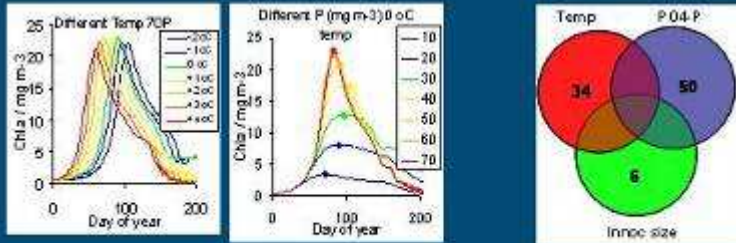
data R. C. Maberly (CEH, UK)

timing of algal spring bloom

245 model simulations

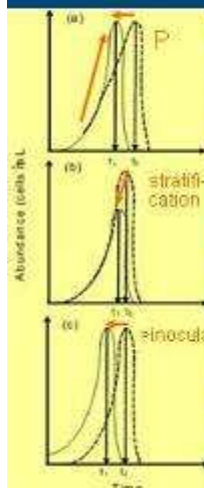
(PROTECH=Phytoplankton Responses To Environmental CHange)

- inflow $\text{PO}_4\text{-P}$ concentration: 10-70 mg/m^3 (7 concentrations)
- water temperatures: -2 to +4°C of average (7 temperatures)
- winter inoculum: 1-5 mg chl-a/m^3 (5 concentrations)



data R. C. Maberly (CEH, UK)

timing of algal spring bloom



potential mechanisms driving earlier spring blooms

higher phosphorus availability reduces the period of slower phosphorus limited growth after the light limited phase (winter) (in case of *Astrionella*)



earlier stratification causes sinking losses to exceed replication earlier in the year (in case of *Cyclotella*)



a higher over-wintering population allows the maximum population size to be reached earlier (in case of both)

Thackeray, Jones & Maberly 2007

climate signal in European lakes



- 18 lakes distributed over Europe (large geographical range)
- 23 year period
- wide range of lakes (shallow to deep, oligo- to eutrophic, short to long residence time, ice-cover yes/no)

meta data analysis to find coherence in response to the climate signal

Blenckner et al 2007

climate signal in European lakes

Meta Data Analysis = a quantitative analysis of a collection of studies/data series

independent variable:

- winter NAO index

dependent (target) variables

- physical: air and water temperature
- chemical: phosphorus, nitrate, silicate
- biological: diatoms, cyanobacteria, dinoflagellates, copepods

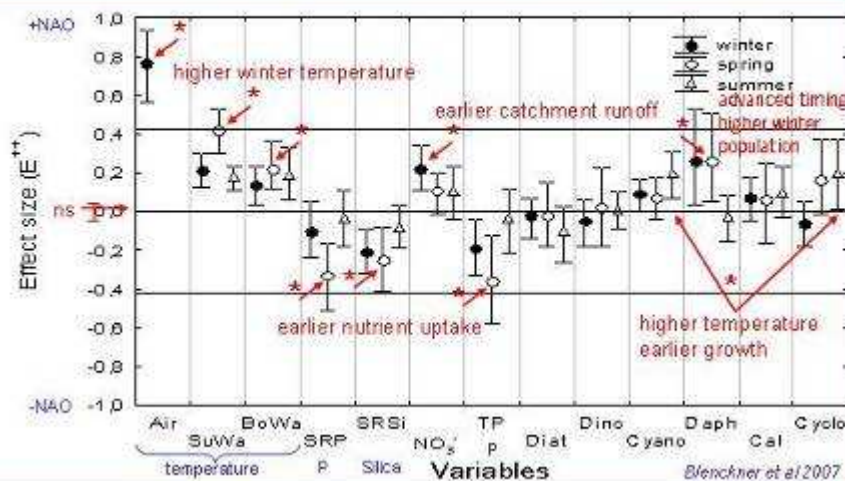


analysis steps:

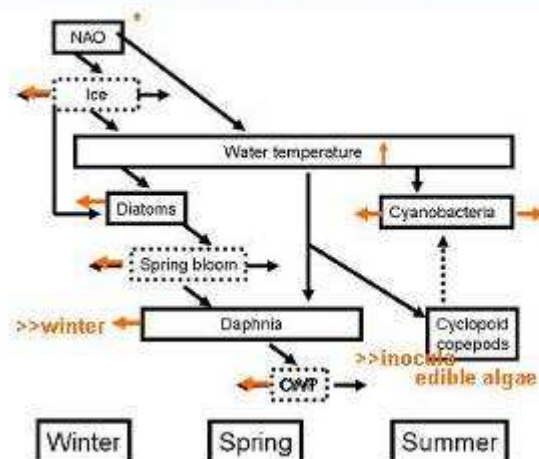
- standardisation (detrending linear or log)
- target variable effect size (E): Pearson's correlation coefficient r
- overall effect size (E^{**}): sum of weighted effect sizes

Blenckner et al 2007

climate signal in European lakes



cascading effects over ± 5 months



Blenckner et al 2007

persistence and stability in Swedish streams



- 5 streams (north-south gradient)
- 11 years (1 per yr)
- macroinvertebrates
- chemistry
- discharge

Sandén 2007

persistence and stability in Swedish streams

macroinvertebrates

persistence (constancy in taxon composition)

- Sorensen similarity ratio
- presence/absence data
- in consecutive years

stability (constancy in number of organisms)

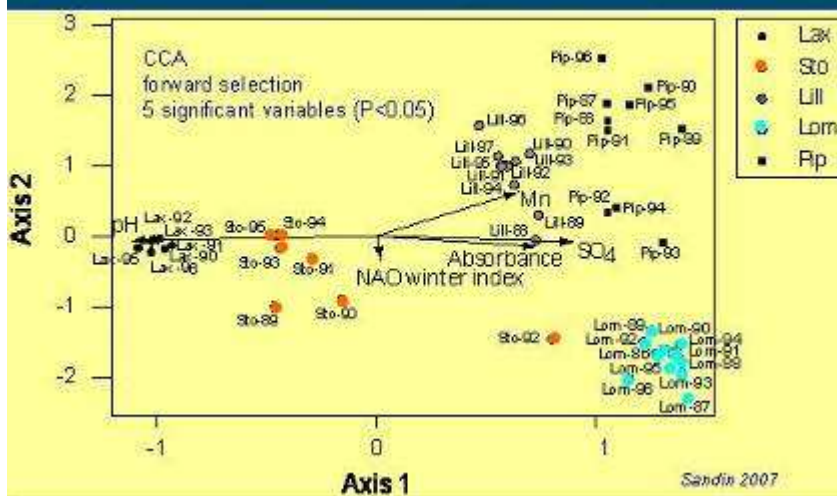
- Spearman's rank correlation
- species abundance data

climate

- winter NAO
- coefficient of variation (CV) winter discharge

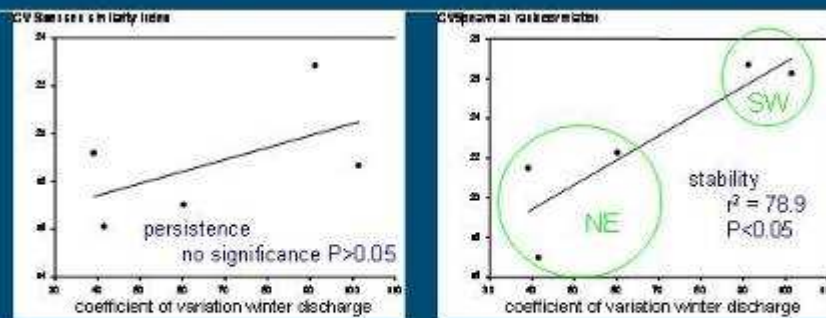
Sandén 2007

persistence and stability in Swedish streams



Sandén 2007

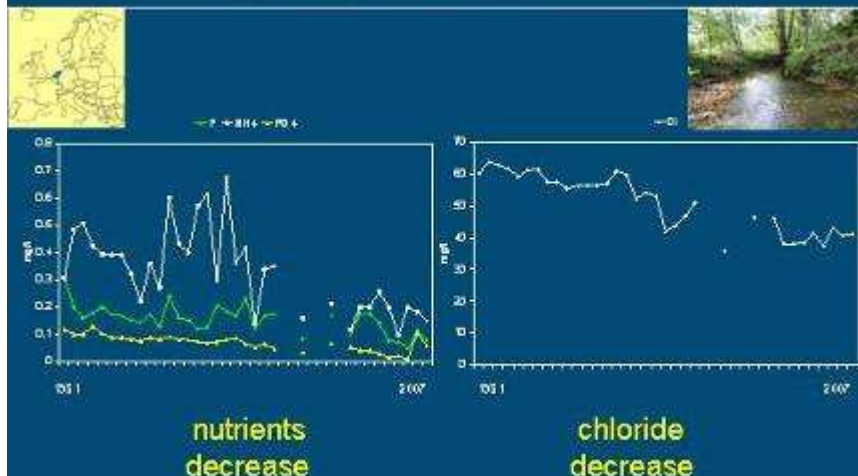
persistence and stability in Swedish streams



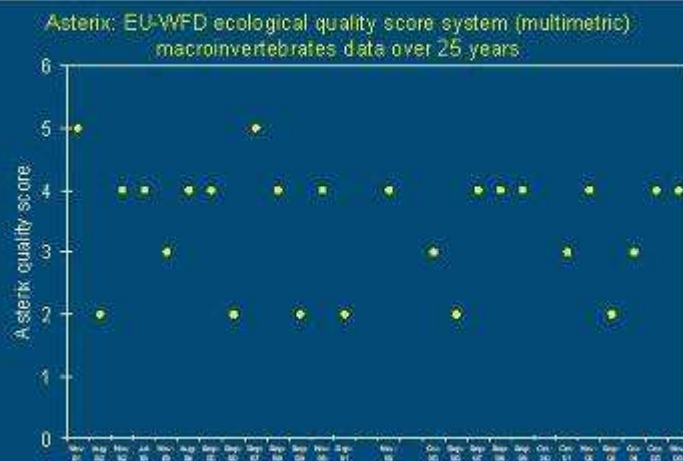
- high cv winter discharge \Rightarrow unstable macroinvertebrate community
- large scale climate affects regional natural variability

Sandin 2007

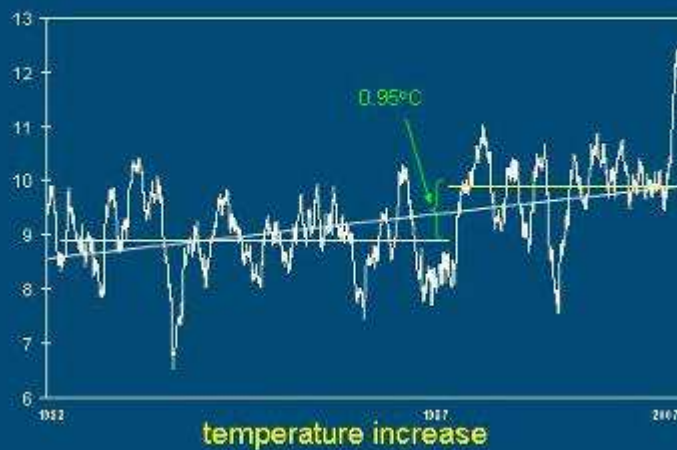
long-term quality score in a Dutch stream



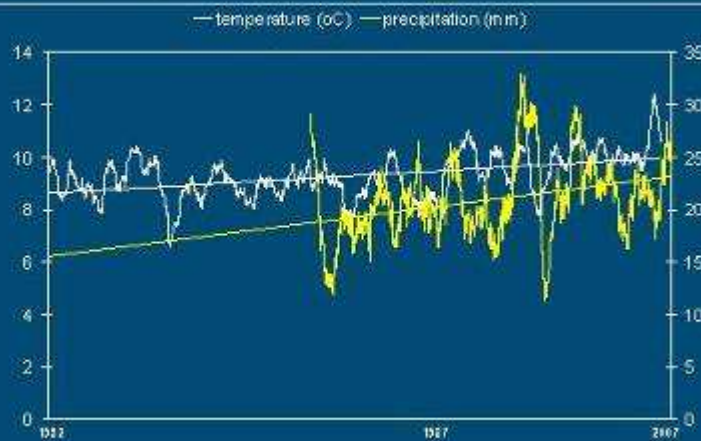
long-term quality score in a Dutch stream



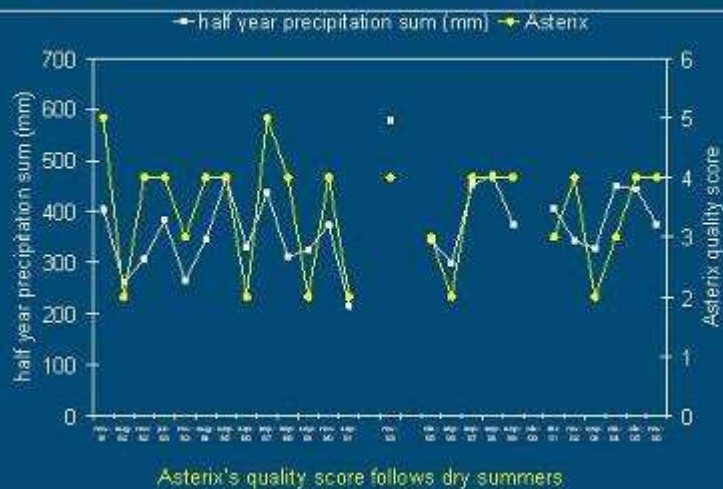
long-term quality score in a Dutch stream



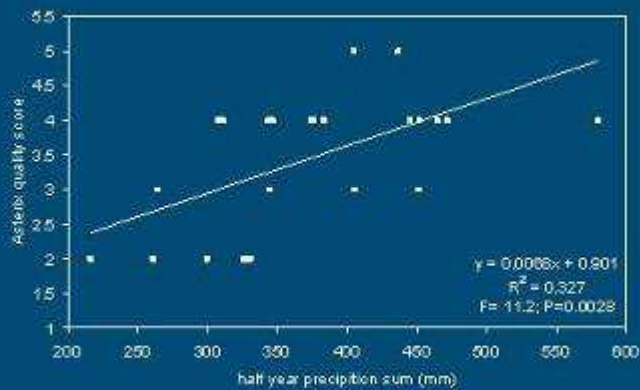
long-term quality score in a Dutch stream



long-term quality score in a Dutch stream



long-term quality score in a Dutch stream



conclusions overall

- historically anthropogenic impact >>> climate impact
- temperature change occurs discontinuous? (thresholds?)
- temperature rise has direct and indirect biotic interaction effects
- seasonal shifts change ecosystem functioning also throughout the year
- precipitation/discharge changes do alter stream ecosystems composition and functioning
- current assessment can have 'overlooked' other signals, like climate



**Thank you for
your attention**

